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Sandhi-Voicing in Dialectal Polish: Prosodic Implications*

Abstract
Sandhi-voicing in dialectal Polish affects word-final obstruents in pre-sonorant and pre-vocalic environments. According to the standard descriptions, the process occurs irrespectively of the 'underlying' laryngeal specification of the consonant. The process has been problematic for phonological theory, with earlier accounts either requiring ad-hoc mechanisms to allow the 'spreading' of [voice], or providing an inadequate explanation of why the process is limited to word boundaries. In this paper, we test the hypothesis that *sandhi*-voicing dialects is a function of weaker word boundaries in the given dialects. Weaker boundaries go hand in hand with weaker initial syllables. We compare the speech of Standard Polish speakers (N=10) with speakers of the Poznań-Kraków dialect (N=10), who recorded sentences containing obstruent-sonorant sequences spanning word boundaries. We found acoustic evidence of weaker initial syllables for two prosodic parameters in the productions of dialect speakers. The relative strength of word-boundaries is described in the Onset Prominence model (OP; Schwartz 2010 et seq.), which also explains the role of manner of articulation in triggering the process.

Keywords
prosody, sandhi-voicing, Polish dialects, word boundaries, phonological representation, phonetics and phonology

Streszczenie
Proces udźwięcznienia *sandhi* w wybranych dialektach języka polskiego dotyczy spółgłosek znajdujących się na końcu wyrazu, które występują bezpośrednio przed kolejnym wyrazem rozpoczynającym się od samogłoski lub spółgłoski zwarto-otwartej. Według tradycyjnych opisów proces ten zachodzi bez względu na to, czy spółgłoska jest z zasady dźwięczna czy bezdźwięczna. Zjawisko to sprawiało problemy dla teorii fonologicznej – wcześniejsze analizy albo wymagają mechanizmów *ad-hoc* pozwalających na rozprzestrzenianie się cechy [voice], albo w niezadowalający sposób tłumaczą ograniczenia kontekstu tego procesu. W tym artykule badamy hipotezę, że w dialektach, w których występuje proces udźwięcznienia, granice wyrazów są słabsze. Porównujemy użytkowników (N=10) standardowej polszczyzny z użytkownikami (N=10) dialektu wielkopolskiego, którzy nagrali zdania za-

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wierające sekwencje spółgłoski właściwej i spółgłoski zwarto-otwartej na granicy wyrazów. Znalezione zostały dowody akustyczne słabszych granic w dwóch parametrach prozodycznych u użytkowników dialektu, co odzwierciedla przywidywania teoretyczne. Przewidywania te pochodzą z modelu Onset Prominence (Schwartz 2010 et seq.), który tłumaczy też, dlaczego proces ten ogranicza się do kontekstu przed spółgłoską zwarto-otwartą, i rolę, jaką stopień otworu artykulacyjnego ma w jego wywoływaniu.

Słowa kluczowe
prozodia, procesy sandhi, dialekty języka polskiego, granice wyrazów, reprezentacja fonologiczna, fonetyka i fonologia

1. Background

At first glance, the question of whether an obstruent is voiced or voiceless seems to be straightforward, yet defining laryngeal categories and the phonetic detail they may or may not encode has proven to be quite a challenge for phonological theory. In this paper, we examine one voicing phenomenon that has been a thorn in the side of phonological analyses for decades: *sandhi*-voicing in dialectal Polish. Polish *sandhi*-voicing is difficult to reconcile with traditional views of laryngeal phonology, so it is necessary at this time to devote some time to illustrating the standard perspective.

Lisker and Abramson's (1964) work established Voice Onset Time (VOT) as a defining phonetic parameter associated with laryngeal systems. Languages with two-way laryngeal contrasts fall into one of two categories, called 'aspiration' and 'true-voice' respectively. The 'aspiration' category distinguishes between plain voiceless consonants with short VOT and consonants with a long VOT, reinforced by h-like aperiodic noise. This category encompasses nearly all Germanic languages (an exception being Dutch), including English. The 'true-voice' category, which includes the Romance and Slavic languages, contrasts obstruents with pre-voicing (or negative VOT, wherein the vocal folds start vibrating before the release of the stop) and plain voiceless consonants with relatively short VOT.

With regard to the phonological representation of this distinction, recent years have witnessed the widespread adoption of a proposal known as 'laryngeal realism' (LR; e.g. Honeybone 2005) in which two-way systems are claimed to be characterized by the use of a single privative laryngeal feature. In both types of system, short positive VOT in obstruents is assumed to reflect a lack of phonological specification, while pre-voicing and long VOT indicate the presence of a phonological feature. In aspiration languages this feature is [spread glottis] ([sg]), or the element |H|, which is assumed to be present in the voiceless series of obstruents. In voice languages the feature [voice] (or element |L|) is posited. Since this paper focuses on Polish, we are of course most interested in aspects of the laryngeal phonology of true-voice languages.

One characteristic of true-voice languages is that clusters of obstruents usually agree in voicing. This is true in Polish across the board, and is nearly always the result of regressive assimilation,[1] by which the first obstruent in the sequence acquires the laryngeal specification of the second. This results in either regressive voicing or regressive devoicing. According to Laryngeal Realism, the former process involves the spread of the feature [voice] from the second obstruent to the first, while the latter is the result of the loss of the [voice] feature in pre-consonantal position in which laryngeal contrast is neutralised.

Across word boundaries, Polish consonant clusters – similarly to word-medial positions – also must agree in voice. Hence, the word-initial C_2 will induce voicing of the preceding, word-final obstruent C_1. As a result, *kot Basi* 'Basia's cat' will be realised as [kɔd baɕi] and *ogród Basi* 'Basia's garden' as [ɔgrud baɕi]. This generalisation holds for all dialects of Polish.

The *sandhi*-voicing process under study in this paper, which is associated with Wielkopolska (Poznań) and Małopolska (Kraków) dialect areas, affects word-final obstruents in the environment before word-initial sonorant consonants and vowels. According to the standard descriptions, the process occurs irrespectively of the 'underlying' laryngeal specification of the consonant. In other words, while the Standard Polish realisation of *sok morelowy* 'apricot juice' would be [sɔk mɔrɛlɔvɨ], Poznań-Kraków Polish would opt for [sɔg mɔrɛlɔvɨ].

Early phonological analyses regarded *sandhi*-voicing and regressive voice assimilation in obstruents as the same process (Bethin 1984; Gussmann 1992; Rubach 1996). The problem for this approach, however, is that that sonorants and vowels, although typically voiced, cannot be claimed to be phonologically specified for a [voice] feature.[2] Thus, these previous accounts were obligated to employ various ad-hoc mechanisms to give sonorants a [voice] specification that can spread to obstruents in sandhi-voicing dialect areas, but only across word boundaries. What is more, the *sandhi*-voicing-as-regressive-assimilation approach is not compatible with phonetic results obtained by Strycharczuk (2012). Her data showed that there was significantly more voicing before voiced obstruents than before sonorants, which suggested that the two processes were, in fact, quite distinct phenomena. In addition, she found that neutralisation in *sandhi*-voicing contexts was optional, and that underlying voiced obstruents were more likely to undergo the voicing process.

An important break in the phonological tradition came with Cyran (2014). He argued that *sandhi*-voicing was an example of "enhanced" passive voicing. Passive voicing is a well-known characteristic of aspiration languages in

[1] In sequences of stop+/v/ and stop+/ʐ/, assimilation is progressive. These fricatives derived historically from sonorants, and their current phonological status is the subject of some debate (see Cyran 2014).

[2] See Rice (1993) for a proposal in which there are two separate [voice] features, one for sonorants and one for obstruents.

sonorant contexts, and Cyran suggested that *sandhi* dialects were identical to aspiration languages in their phonological specification. That is, the voiced series is unspecified, while the voiceless series are marked with the feature [sg] (or element |H|). Thus, instead of having to add a [voice] specification to sonorants and vowels, Cyran proposed that in word-final positions obstruents in dialectal Polish lose their |H| specification; what is left is an obstruent that is subject to passive voicing due to its occurrence in a voiced environment. Therefore, *sandhi*-voicing was treated as a purely phonetic process, which did not involve any form of feature spreading.

Cyran's proposal, which he calls Laryngeal Relativism, carries with it a direct challenge to Laryngeal Realism in its claim that 'true voice' languages need not have |L|/[voice] specification. While this account is quite compelling, it also entails a number of unresolved issues. Most importantly, unless we assume that the phonetics-phonology relationship is completely arbitrary, Cyran's claim that the two dialects of Polish have opposing laryngeal systems must be considered controversial, since in 'non-neutralizing' positions they behave identically. A more intuitively appealing approach would suggest that the laryngeal specifications in the two dialect areas are identical, explaining their identical behaviour in other positions. The difference, then, must lie in the representation of word boundaries. We hypothesise that boundaries are weaker in *sandhi*-voicing dialects, which makes final obstruents more susceptible to voicing.

A natural corollary of our hypothesis is that, due to weaker word boundaries, word-initial syllables will also be weaker in *sandhi*-voicing dialects. Word-initial syllables in standard Polish typically bear some degree of phonetic prominence (Dogil 1999). This prominence is not, we claim, due to secondary stress, but rather serves as a boundary marker (Newlin-Łukowicz 2012) that maintains the prosodic integrity of words. Weaker initial syllables should be expected to produce an environment conducive to *sandhi*-voicing in which the boundary marking prominence of those syllables is reduced. Therefore, this paper will present a phonetic study on the prosodic implications of the *sandhi*-voicing process. In particular, we will compare the acoustic phonetic prominence of initial syllables, as well as initial sonorant consonants, in *sandhi*-voicing dialects and in standard Polish. Section 2 of this paper will describe the methodology of our phonetic study and present the results. Section 3 will provide an overview of a phonological model, the Onset Prominence representational framework, that accounts for boundary strength in the two varieties of Polish. Section 4 concludes.

2. The present study

This section describes a production study of obstruent-sonorant (C#R) sequences spanning word boundaries in the speech of *sandhi*-voicing dialect speakers, compared with a control group of Standard Polish speakers. The study attempted to investigate the following research hypothesis: although initial syllables typically bear phonetic prominence in standard Polish (Dogil 1999, Newlin-Łukowicz 2012), weaker boundaries in *sandhi*-voicing dialects should go hand in hand with less prominent initial syllables,[3] manifested in the strength of the sonorant consonant relative to the following vowel, or the relative prominence of the initial vowel to the stressed penultimate vowel.[4] In addition to the prosodic analysis of sonorant-initial words, we also looked at the voicing of final obstruents. Thus, in what follows, we will refer to both a voicing analysis and a prosody analysis.

2.1. Participants

Our participants were divided into two groups: the *sandhi*-voicing dialect speakers and a control group with no history of speaking the Poznań-Kraków dialect. The former consisted of 11 speakers from Oborniki Wielkopolskie, which is a town situated 30 kilometres north of Poznań (Greater Poland voivodeship) with a population of some 18 450 inhabitants. Seven of the speakers were female and four were male. They were all between the ages of 14 and 53 (median age: 21 years old), and they had lived in that area from birth. The latter group comprised 10 second year students of the BA programme at the Faculty of English, Adam Mickiewicz University (UAM) in Poznań and were used as controls. They were all females aged 21–22 years old (median age: 21) and spoke Standard Polish, claiming to not have had any history of speaking any non-standard dialect.

The validity of our 'voicing' group was verified by preliminary acoustic and auditory analysis performed in the Praat program (Boersma & Weenink 2011). One speaker from the Oborniki group did not reliably produce *sandhi*-voicing and was excluded from the analysis. Therefore, the analysis we report on here comes from two groups of ten speakers each.

2.2. Materials

The dataset for our study was made up of 48 sentences with C#R clusters (see: Appendix 1). We chose four sonorant-initial words for each of the following /j, m, l, r/, yielding 16 target words. These were all put in three different contexts:

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[3] A reviewer raises the question of whether the 'metrical systems' in the two dialects may differ. This is not our claim. Rather the claim is that the inherent initial prominence, irrespective of larger metrical organisation, is weaker in the voicing dialects.

[4] A reviewer raises the question of *sandhi*-voicing in cases where the second word has two syllables, so the initial and the penult are one and the same, and of course are phonetically prominent. If *sandhi*-voicing is a function of weaker boundary marking, there is a prediction that voicing dialects should have somewhat less prominent initials in two syllables words as well. This is an empirical question that may be taken up in the future.

- underlyingly voiceless obstruent # R;
- underlyingly voiced obstruent # R;
- vowel # R.

With 16 target words, three contexts yielded a total of 48 C#R sequences. In preparation of the datasets an attempt was made to control for factors which could influence the results. We made sure that the sentences were not too long and that the target words did not appear too late in the sentence. All target words were at least three-syllables long so as to control for stress and the vowel following the sonorant – or the initial vowel in the case of V # R sequences – was always either low or mid. The obstruents in the final position were counterbalanced with regard to place of articulation and voicing (labial, coronal, and velar, both the voiced and voiceless series). Finally, none of the obstruent-final words was a preposition or a pronoun as these tend to be voiced in a pre-sonorant position also in Standard Polish.

With 48 sentences and 20 speakers, we recorded a total of 960 sentences. For the prosodic analysis, /j/-initial target words were excluded due to the difficulties in determining segmental boundaries. For voicing analysis the vowel-final context was of course excluded. After all exclusions, which included also speaker hesitations, errors, and deletions, 680 items were analysed with regard to prosody and 540 items were included in the voicing analysis.

2.3. Procedure and analysis

The carrier sentences containing the tokens were presented to the participants on Power Point slides, with the researchers controlling the pace with which the sentences appeared on screen. The speakers of the *sandhi*-dialect were recorded in quiet rooms in the homes of the Oborniki speakers, while the control group were recorded in a sound-treated booth at the Faculty of English at Adam Mickiewicz University in Poznań. Both groups were recorded directly onto laptop, using high quality head-mounted microphones and a USB audio interface. The recordings were made at sampling rate of 44 kHz, with 24 bit quantization, and were subsequently annotated in Praat (Boersma and Weenink 2011).

On the basis of the annotation, an example of which is shown in Figure 1, a number of acoustic measures were extracted using a Praat script. For the prosodic analysis, these included a measure of Onset Strength calculated as the duration of the word-initial sonorant consonant relative to the duration of the following vowel, and three acoustic measures of prominence (Duration Ratio, Intensity Ratio, and Pitch Ratio) of the first vowel in the target word relative to the stressed penultimate vowel. Each of these measures was based upon the ratio of the given acoustic feature (duration, intensity, pitch) in the initial vowel to the stressed penultimate vowel. These measures were extracted from the 1st (top) tier in Figure 1. For the voicing analysis, we measured the duration of voicing in the final obstruent and the overall duration of the final obstruent, from which a Voice Ratio was calculated (calculated from duration values extracted from the 2nd and 3rd tiers in Figure 1). For statistical analysis, Generalized Linear Mixed Models were performed in the SPSS statistical program (IBM Corporation 2013), with acoustic measures as dependent variables, Group as the main fixed factor, and Item and Participant as random factors.

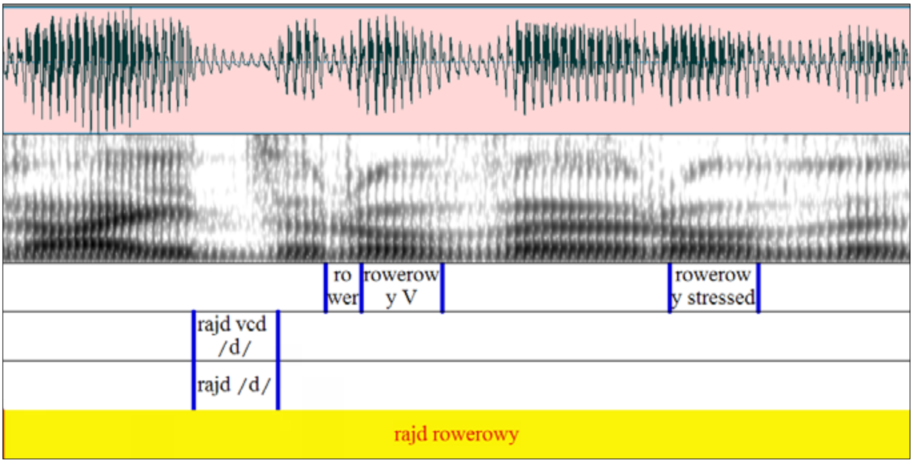

Figure 1. An example of an annotated token

2.4. Results

Table 1 presents mean values for each of the prosodic parameters for each group, alongside 95% confidence intervals for the measures. In each of the parameters, the mean was greater in the UAM group (non-dialect speakers) than in the Oborniki group.

Table 1. Mean values and 95% confidence intervals for prosodic prominence ratios

Prominence Ratio	Group	Mean	95% Confidence interval – low	95% Confidence interval – high
Onset Strength	UAM	0.88	0.84	0.92
Onset Strength	OBO	0.81	0.77	0.86
Vowel Duration	UAM	0.94	0.90	0.97
Vowel Duration	OBO	0.91	0.87	0.94
Intensity	UAM	1.021	1.015	1.026
Intensity	OBO	1.011	1.008	1.015
Pitch	UAM	1.06	1.03	1.09
Pitch	OBO	1.01	0.99	1.03

Statistical tests of the prosodic measures revealed significant effects of Group were observed for two of the prosodic measures: Intensity Ratio and Pitch Ratio. For both of these measures, the vowel in the initial syllable was more prominent in the speech of the UAM group relative to the Oborniki group. The results of the these two tests are given in Tables 2 and 3. No significant effects of Group were observed for Onset Strength or Vowel Duration Ratio.

Table 2. Results of linear model for Intensity ratio

Intensity Ratio	**Coefficient**	**Std. Error**	**t**	**Sig.**
Intercept	1.012	0.004	224.87	<.001
Group:UAM	0.011	0.003	***3.44***	***.001***

Table 3. Results of linear model for Pitch ratio

Pitch Ratio	**Coefficient**	**Std. Error**	**t**	**Sig.**
Intercept	1.008	0.023	43.0	<.001
Group:UAM	0.06	0.024	***2.49***	***.013***

For the voicing analysis, we were interested in whether the laryngeal contrast appeared to be neutralised. The mean values for the Voice Ratio measure as a function of underlying voicing are shown in Figure 2. In the figure it appears as though neither group neutralised the contrast, although as expected the Oborniki group showed more voicing across the board. The linear model confirmed the lack of neutralisation in the voicing measure ($p=.207$).

A closer look at the voicing ratio data revealed a bimodal distribution, with a large spike of tokens produced with full voicing, and another set of tokens with a mean Voice Ratio of about 35%. This is shown in Figure 3.[5] Because of this distribution, an additional mixed-effects regression analysis was run, this time with binary logistic regression, with Fully Voiced (100% voicing ratio) as a binary variable (yes or no), and Underlying Voicing as a the main fixed factor of interest. Once again, Underlying Voicing failed to have a significant effect ($p=.08$) – underlying voiced and voiceless items were equally likely to be realised as Fully Voiced.

[5] A reviewer asks about the degree to which the bimodal distribution held over individual subjects. Since our preliminary auditory analysis was aimed at defining groups of voicers and non-voicers, individual variation is not a priority for this study. Preliminary examination of histograms for each individual speaker suggests that the bimodal distribution indeed held for a majority of the speakers.

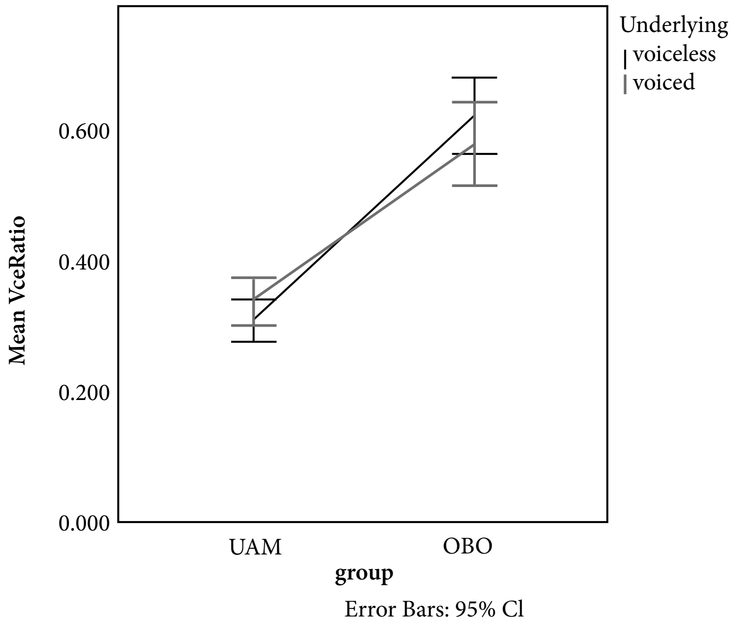

Figure 2. Mean voicing ratio for each group, sorted for underlying voicing

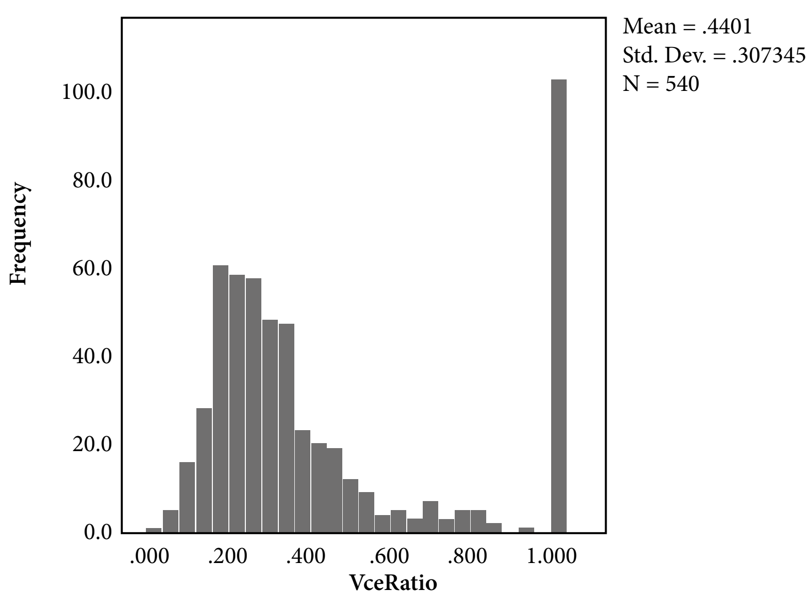

Figure 3. Histogram of items by voicing ratio measures

We also examined whether the type of sonorant consonant had any effect on the amount of voicing in the final obstruents. Figure 4 shows mean voice ratio results as a function of sonorant type.

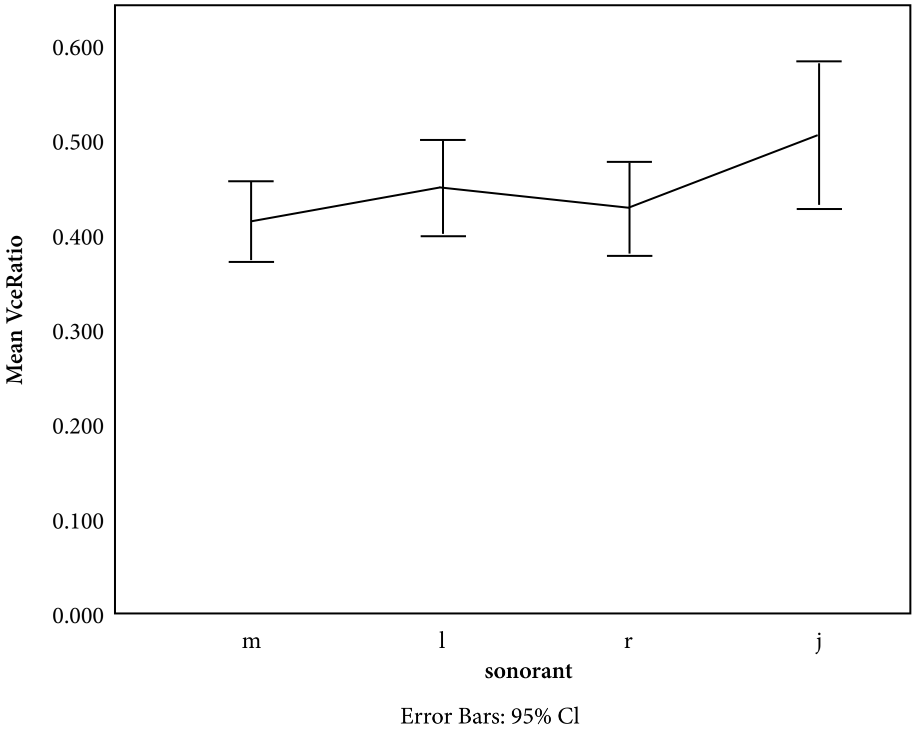

Figure 4. Mean voice ratio as a function of sonorant type

Results of a linear mixed-effects regression model are given in Table 4, in which we can see that the /j/ was associated with more voicing than each of the other types of sonorant, as is suggested in Figure 4.

Table 4. Results of linear model showing effects of sonorant type on voicing ratio

Voice Ratio	Coefficient	Std. Error	t	Sig.
Intercept: /m/	0.396	0.57	6.93	<.001
/j/	0.138	0.048	***2.87***	***.004***
/r/	0.037	0.044	0.83	.408
/l/	0.057	0.044	1.31	.190

2.5. Discussion

The results of our empirical study may be summarised as follows. It has been observed that there was, indeed, more voicing in *sandhi*-voicing dialects (see Figure 2), with /j/ generating a higher voicing ratio than other sonorants. We will consider this finding briefly in Section 4, which concludes the paper.

Interestingly, we found no evidence of contrast maintenance in either the Oborniki group or the standard Polish group, a finding that contrasts with the findings of Strycharczuk (2012). In attempting to explain this discrepancy, we may speculate that the education level and place of residence of the speakers may have played a role. Strycharczuk's speakers were all university students living in Poznan, which is a major urban centre. This may have led to greater awareness of underlying contrasts, and perhaps also a greater sensitivity to correctness, than in the speech of the Oborniki group, who come from a provincial town and are in general characterized by a lower level of education. One finding of ours that does mirror Strycharczuk's study is the bimodal distribution of Voicing Ratio (Figure 3), which suggests that the voicing process is optional and categorical, rather than gradient.

With regard to prosody, the *sandhi*-voicing dialect showed weaker initial vowels in Intensity Ratio and Pitch Ratio. Therefore, the hypothesis that *sandhi*-voicing dialects are characterised by weaker initial syllables, which entails weaker word boundaries and that this environment is more conducive to voicing, has found some support in our findings. Accepting the hypothesis that boundary strength is of importance when accounting for *sandhi*-voicing phenomenon in dialectal Polish, phonology requires a framework whose formal representation could explain *how* word boundaries differ in the two dialects. In what follows, we shall present representations in the Onset Prominence model (OP; Schwartz 2010 et seq.), which encode the relative pre-sonorant boundary strength of the two dialect types.

3. Laryngeal phonology and boundary strength in the Onset Prominence framework

This section will present the OP perspective on Polish *sandhi*-voicing, which is compatible with our experimental data. The theoretical proposal is built on representations from Schwartz (2016a), and first applied to the problem of Polish *sandhi*-voicing in Schwartz (2016b).

The Onset Prominence representational framework is built on a hierarchy derived from the phonetic events associated with a stop-vowel sequence. This is shown in Figure 5. The top node (Closure; C) is derived from stop closure, the Noise (N) node from aperiodic noise associated with frication and stop release bursts, the Vocalic Onset (VO) node captures periodicity with formant structure associated with CV transitions as well as sonorant consonants. The Vocalic Target (VT) node houses (more or less) stable formant frequencies that define vowel quality.

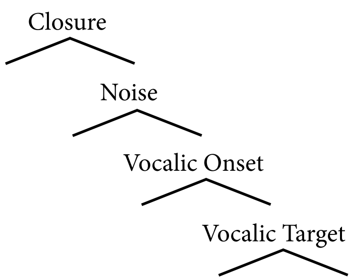

Figure 5. The Onset Prominence representational hierarchy

A crucial aspect of Onset Prominence (henceforth OP) framework for the purposes of explaining Polish *sandhi*-voicing is the claim that manner of articulation is a structural property, defined in terms of the active (binary) nodes in a given segment's representation. OP manner categories are shown in Figure 6. The segmental symbols are shorthand for place and laryngeal specifications.

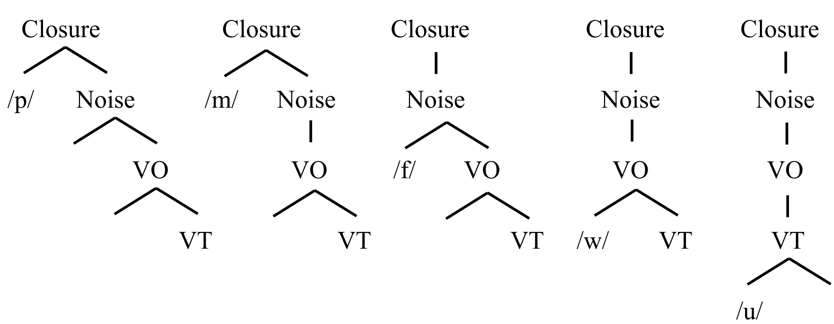

Figure 6. Manner of articulation in the OP framework

As we shall see, the manner-as-structure postulate allows the model to encode the pre-sonorant aspect of the process. For a thorough account of the representation of manner of articulation in the OP framework, see Schwartz (2016a). However, before dealing with the effects of manner of articulation on boundary strength, we must consider how OP deals with laryngeal contrasts.

3.1. Laryngeal phonology in OP

In presenting the OP approach to laryngeal phonology (see Schwartz 2017), it is necessary to emphasise two somewhat independent theoretical assumptions. The first, which concerns the choice of laryngeal specification, is in fact not directly related to OP's structural view of segmental representation. Based on Traunmüller's (1994) Modulation Theory, in which phonological features reflect salient modulations on a voiced carrier signal, it is claimed that the feature [voice] (or element |L|) does not play a directly role in laryngeal contrasts, even in 'true-voice' languages. Thus, we posit only a single laryngeal feature, [sg] (or element |H|) for most two-way laryngeal contrasts. In essence, the Modulation approach gives credence to Cyran's claim that the element |H| may be active in Polish *sandhi*-voicing dialects. However, we suggest that Cyran does not go far enough, and claim that |H| is active in all dialects of Polish, and that |L| is absent. In other words, all voicing in Polish obstruents is enhanced passive voicing, additionally motivated by the need to maintain perceptual distinctiveness of the laryngeal contrasts in the absence of aspiration. It is not the reflection of a feature [voice] or element |L|.

The second assumption is that laryngeal typology makes crucial use of the hierarchical aspects of OP representations in encoding the difference between true-voice and aspiration languages. To visualize how OP reconciles these two assumptions, consider Figure 7, in which we see representations for an aspiration systems (the left-hand pair of trees) and true-voice systems (the right-hand pair of trees). The difference between the two types of system is the hierarchical level at which the element |H| is assigned. 'Aspiration' languages assign |H| at the Closure level from which it then 'trickles' down onto the Noise level, which is reflected in aspiration noise. By contrast, 'true voice' languages assign |H| at the VO level leaving the Noise node unaffected, so the stop is realised as a plain voiceless consonant. In both languages the voiced series of stops is unspecified for laryngeal properties.

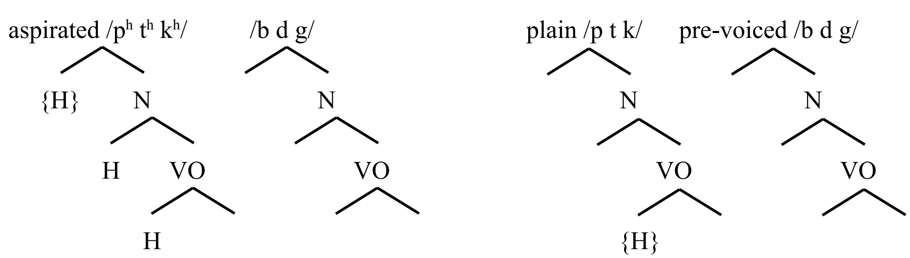

Figure 7. OP representations of laryngeal contrasts: aspiration (left pair of trees) vs. true voice systems

The above structures showcase instances wherein the stop is followed by a vowel, which gives it the support of the VO node. If, however, the vowel is missing from the signal because the stop occurs in a word-final position, what is left is a neutralised allophone, made up of the Closure and Noise nodes, while VO is left as a unary placeholder defining the level of laryngeal assignment (for more on unary nodes in OP, see Schwartz 2016a: 43). The three possible structures for Polish stops, then, are presented below in Figure 8. Trees A and B represent a voiceless and voiced stops respectively while Tree C illustrates the neutralised word-final allophone.

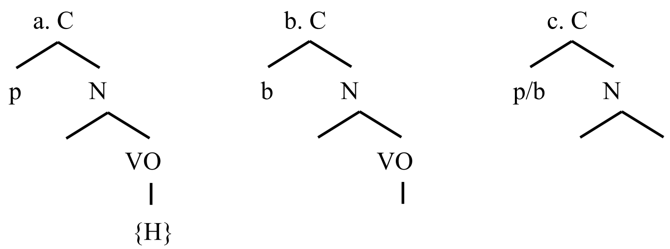

Figure 8. Three possible representations for Polish stops in OP: voiceless, voiced, and a neutralised allophone respectively

It is important to note that these structures predict the categorical but optional voicing observed in the bi-modal distribution in Figure 3, as well as in Strycharczuk's results. In essence, speakers only have three possible variants of a stop to choose from, and two of them may be expected to result in enhanced passive voicing in pre-sonorant consonants. The other thing to note here is that the representations in Figure 8 are agnostic to the question of neutralization. Depending on which variant speakers use, contrast may or may not be neutralized. Indeed, the question of neutralisation is of secondary theoretical importance in this study, despite the fact that it has been hotly debated in the literature (see e.g. Manaster-Ramer 1996; Port 1996).

3.2. The representation of *sandhi*-voicing and boundary strength

The representation of boundaries in the OP framework is derived from the relationship between individual 'segmental' trees (as in Figure 6) and larger prosodic structures. This relationship is in large part defined in terms of a single mechanism, absorption (Schwartz 2016a: 43–44), by which lower-level structures are merged with higher-level structures to their left. In practice, absorption typically entails either the merger of a vowel with an "onset" consonant to form a CV, or an approximant consonant with a preceding obstruent to form a rising 'sonority' consonant cluster. Figure 9 below shows a representation of the English word *cry*, which illustrates two instances of absorption. First the vowel (tree C) is absorbed into the /r/ (tree B), then that whole structure merges with the /k/ (tree A), forming a single structure (tree D).

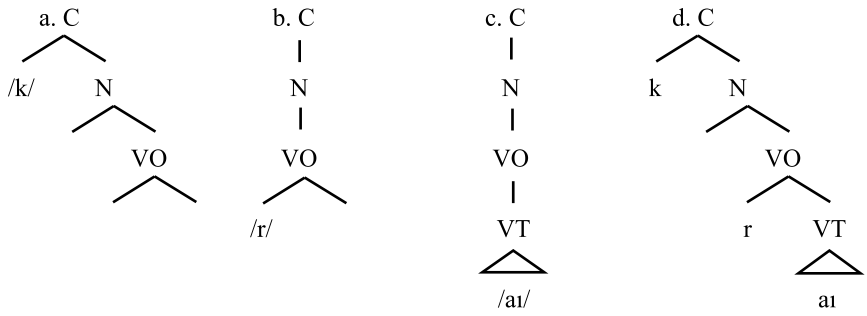

Figure 9. Absorption in English *cry*

As is evident in Figure 9, the OP model essentially equates 'sonority' with hierarchical level – lower-level structures are more sonorous. In this way the cross-linguistic preference for rising sonority onsets is the direct result of the absorption mechanism. However, as is well-known, Polish is a language with a large number of violations of the sonority sequencing generalisation, suggesting that the language employs other mechanisms in addition to absorption to determine the segmental content of prosodic constituents.

One such mechanism used by Polish is called 'promotion' (Schwartz 2016a: 54–58), by which unary nodes are eliminated, and lower level binary nodes are raised to join remaining structures. This operation is shown in Figure 10; the left-most tree illustrates promotion, the right-most tree a sequence of a promoted sonorant and a vowel.

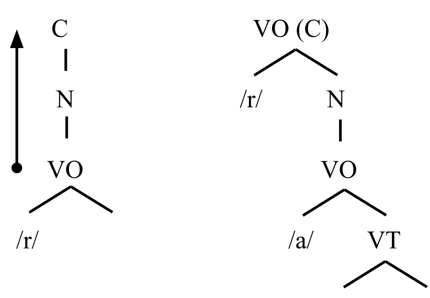

Figure 10. 'Sonorant promotion' and a sequence of a sonorant and a vowel in Polish

As a result of promotion, sonorants in Polish are not absorbable into preceding obstruents, and consonant clusters must be adjoined at a higher level of structure. One consequence of promotion in Polish is that onset clusters may count for prosodic weight (e.g. Comrie 1976), unlike in English. Thus, Polish allows CCV content words (*gra* 'game'), but not CV content words (**ga*, **ra*).

In essence, promotion is a strengthening process in a model in which strength is envisioned as being at a higher level in the OP hierarchy. A similar configuration may be formed from word-initial vowels by activating the Closure node, which typically entails glottalisation, a process found in Standard Polish and illustrated in Figure 11.

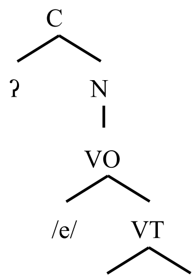

Figure 11. Vowel glottalisation in Polish

The promotion mechanism, as well as vowel glottalisation, may be shown to have effects for boundary strength in Standard Polish and *sandhi*-voicing dialects. Our basic claim may be stated as follows. Speakers of *sandhi*-voicing dialects have less firmly internalised representations of promoted sonorants and glottalised vowels. In the case of the latter, Schwartz (2013) found that vowel glottalisation is less prevalent among Wielkopolska speakers than speakers of standard Polish. Thus, *sandhi*-voicers are claimed here to lean toward weaker, non-promoted/non-glottalised initial sonorants and vowels. As a consequence, in these dialects C#R and C#V boundaries may give rise to an absorption context, increasing the likelihood that the two words will be pronounced together. In other words, boundaries are weaker because their configuration mirrors structures that a tendency to be joined via absorption.

A crucial aspect of the OP framework is that word boundaries are not represented with any kind of diacritic symbol (such as #), but are read directly off of the trees. The phonological shape of words, and therefore the boundaries between them, is determined by mechanisms such as absorption and promotion. These are not 'processes' in synchronic grammar. Rather, they diachronic operations that create templates for the structure of prosodic constituents. At the same time, however, the mechanisms open the door for synchronic representational ambiguity to which speakers may be sensitive. With regard to *sandhi*-voicing, we claim that speakers contain subconscious knowledge of the ambiguity involved in the distinction between 'promoted' vs. 'non-promoted' sonorants. The difference between the two dialects is that *sandhi*-voicers have greater sensitivity to the non-promoted variants.

OP representations of boundary strength in the two dialects are shown in Figures 12 and 13, illustrating the phrases *kot Radka*/*kot Ani* 'Radek's cat'/'Ania's cat'. In Figure 12 we see Standard Polish. The Closure node is active in the word-initial segments, and as a result the absorption configuration is not created. The boundary is strong.

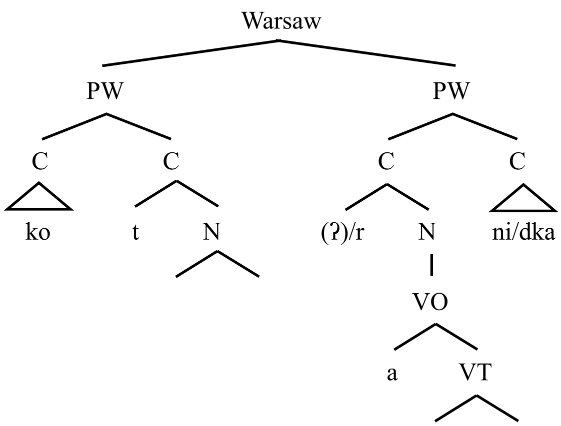

Figure 12. Boundary strength in a non-voicing dialect

Figure 13 illustrates a *sandhi*-voicing variety. It lacks an active Closure node for the sonorant and initial vowel, which makes the boundary weaker.

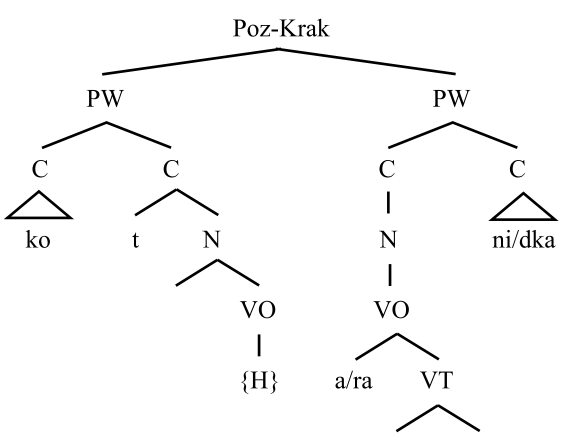

Figure 13. Boundary strength in a *sandhi*-voicing variety

There are two implications of the representational differences between the varieties shown in Figures 12 and 13. First and foremost, the weaker boundaries place the word-final obstruent more firmly in an inter-sonorant context conducive to enhanced passive voicing. The other implication concerns speakers' choice of 'allophone' for the word-final stop. When boundaries are weaker, speakers may be more likely to choose the non-'final' variant of the obstruent, allowing for the maintenance of the laryngeal contrast. Contrast maintenance is what Strycharczuk (2012) found in her study. At the same time, however, in our study the contrast was apparently neutralized. The OP account makes no specific predictions about neutralization – both neutralization and the lack thereof are possible. What is predicted, however, is that voicing is optional but not gradient, which was observed both in the present study and in that of Strycharczuk.

4. Final remarks

The results of our phonetic study provide some support to the hypothesis that there exists a link between *sandhi*-voicing and the relative prominence of word-initial syllables. The data presented suggest that weaker initial syllables reflect weaker word boundaries in *sandhi*-dialects. The strength of word boundaries may be encoded with Onset Prominence representations by means of deactivating boundary strengthening mechanisms between obstruents and sonorants across word boundaries.

One additional finding of our study is that the glide /j/ was more likely to induce voicing than the other sonorants tested (/m/, /l/, /r/). From the standpoint of OP representations, this finding suggests that the glide is less likely than the other sonorants to undergo promotion (the /m/, as a nasal, already features an active Closure node). Clearly this is related to its 'sonority' – glides are more 'sonorous' than liquids and nasals. As yet, OP accounts of sonority differences between e.g. glides and liquids have not been developed. However, we suggest that this problem does not bear directly on OP structures themselves. Rather, this behaviour is presumably a function of the melodic specifications that attach to those structures. While a preliminary proposal for a more refined view of melodic specifications in the OP environment may be found in Schwartz (2017), a complete account remains a task for future research.

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Appendix 1. C#R sequences recorded by the participants:

- *jak leczono*
- *osób leczonych*
- *choroby leczono*
- *pamiętnik legendy*
- *według legendy*
- *miejskie legendy*
- *samolot lecący*
- *pokład lecącego*
- *odgłosy lecącego*
- *zakup londyńskich*
- *grób londyńskiego*
- *giełdę londyńską*
- *nawet matematyka*
- *lub matematyki*
- *zadanie matematyczne*
- *obrót milionami*
- *wśród milionów*
- *zarobiła miliony*
- *syrop malinowy*
- *lub malinowym*
- *lody malinowe*
- *pestek moreli*
- *sad morelowy*
- *napoju morelowym*
- *akurat jesienią*
- *naród jesienią*
- *czasu jesienią*
- *smak jabłecznika*
- *zrób jabłecznik*
- *najlepszy jabłecznik*
- *pająk jadowity*
- *gad jadowity*
- *to jadowite*
- *tak jaskrawe*

- *wymóg jaskrawych*
- *niedawno jaskrawe*
- *lat rysopis*
- *według rysopisu*
- *dokładnego rysopisu*
- *brak rachunku*
- *błąd rachunkowy*
- *wysoki rachunek*
- *sklep rowerowy*
- *rajd rowerowy*
- *rajdzie rowerowym*
- *rysunek rakiety*
- *lub rakietę*
- *się rakietą*